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PATENT SPECIFICATION

Convention Date (United States): March 31, 1936.

487,356

Application Date (in United Kingdom): March 31, 1937. No. 9120/37.

Complete Specification Accepted: June 20, 1938.

COMPLETE SPECIFICATION

-- of and Furnace for Heating Fluids

ERRATUM

SPECIFICATION No. 487,356.

Page 1, line 69, *for* " temperature " *read* " temperatures "

THE PATENT OFFICE,
July 23rd, 1938.

improved ... employing a vertical bank of horizontally disposed tubes, comprising either one or more vertical rows so arranged that heat is imparted to the opposite sides of each tube by direct radiation from materials undergoing combustion in combustion zones located on opposite sides of the tube bank between the latter and the side walls of the furnace and also by heat radiated from the hot refractory side walls. This type of heater has now become generally known in industry as the " equiflux " furnace and several embodiments thereof have proven highly successful and advantageous as applied to the pyrolytic conversion of hydrocarbon oils.

In the heater described in our Specification No. 437,543, the combustible materials were preferably supplied to each combustion zone in a downward direction through firing ports located within the roof of the furnace, the general direction of flow of the combustion gases being downward through the combustion zones and the gases subsequently passing from the combustion zones in a generally horizontal direction and upwardly through a separate bank of tubes, wherein they impart heat by convection to the oil passing through the tubes, prior to their discharge to the

[P...]

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The expression " stream-line flow " i... intended to be understood in its now generally accepted meaning as applied to the flow of fluids, that is to say, the flow of the combustion gases occurs in a substantial... ...ner with a minim... ...n the direction of the gaseous stream, so that a steady state of the heating conditions within the furnace can be readily attained.

In the present invention, combustible materials are supplied to each combustion zone through firing ports located within the floor of the furnace and the general direction of flow of the combustion gases is upward through the entire length of the combustion zones follow-

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Process of and Furnace for Heating Fluids

We, UNIVERSAL OIL PRODUCTS COMPANY, a Corporation organised under the Laws of the State of Delaware, United States of America, of 310, South Michigan Avenue, Chicago, Illinois, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to an improved process and apparatus for the heating of fluids and is particularly directed to heating hydrocarbon oils to the high temperature required for their pyrolytic conversion.

In our patent Specification No. 437,543, we have described an improved method of heating fluids and an improved type of heater therefor, employing a vertical bank of horizontally disposed tubes, comprising either one or more vertical rows so arranged that heat is imparted to the opposite sides of each tube by direct radiation from materials undergoing combustion in combustion zones located on opposite sides of the tube bank between the latter and the side walls of the furnace and also by heat radiated from the hot refractory side walls. This type of heater has now become generally known in industry as the "equiflux" furnace and several embodiments thereof have proven highly successful and advantageous as applied to the pyrolytic conversion of hydrocarbon oils.

In the heater described in our Specification No. 437,543, the combustible materials were preferably supplied to each combustion zone in a downward direction through firing ports located within the roof of the furnace, the general direction of flow of the combustion gases being downward through the combustion zones and the gases subsequently passing from the combustion zones in a generally horizontal direction and upwardly through a separate bank of tubes, wherein they impart heat by convection to the oil passing through the tubes, prior to their discharge to the stack. Nevertheless, in our Specification No. 437,543, the possibility of firing the furnace from the bottom instead of from the top is mentioned.

The present invention is concerned with improvements in the use and construction of the "equiflux" type of furnace referred to above, particularly with an improved method of firing and the direction of flow of the materials undergoing combustion and resulting combustion gases within the furnace.

The present invention provides a process for heating fluids and particularly heating hydrocarbon oils to the high temperature required for their pyrolytic conversion, which comprises passing oil through horizontal tubes of a vertical tube bank disposed between two combustion and heating zones, heating opposite sides of each of said tubes by direct radiation from materials undergoing combustion within said combustion zones, supplying controlled amounts of combustible fuel and air to the lower portion of each of said combustion zones, and causing the resulting flames and combustion gases to pass in a generally upward direction throughout the entire length and out of each combustion zone, the combustion gases passing through each of the two co[illegible] bustion zones in substantially stream-line flow and being removed through an outlet located centrally above sai[illegible] [illegible]bustion zones and the tube bank.

The expression "stream-line flow" i[illegible] intended to be understood in its now generally accepted meaning as applied to the flow of fluids, that is to say, the flow of the combustion gases occurs in a substan[illegible] [illegible]ner with a minim[illegible] [illegible]n the direction of the gaseous stream, so that a steady state of the heating conditions within the furnace can be readily attained.

In the present invention, combustible materials are supplied to each combustion zone through firing ports located within the floor of the furnace and the general direction of flow of the combustion gases is upward through the entire length of the combustion zones follow-

ing which the combustion gases contact with a separate bank of tubes in a heating zone located above and centrally in relation to the combustion zones wherein they continue to travel in a general upward direction and impart heat by convection to the oil passing through the tubes.

The upshot method of firing provided by the invention cooperates with the natural draft tendency of the vertical furnace structure resulting in an upward and substantially stream-line flow of combustion gases throughout the entire furnace and, in cooperation with the provisions of the invention for directing combustible fuel and air into the lower portion of the combustion zones at an angle toward the refractory side walls of the furnace, localized over-heating of the tubes in the equiflux bank by flame impingement is minimized.

Furthermore, the arrangement of the various elements of the furnace provided by the present invention permits a less expensive furnace structure as compared with downfired "equiflux" heaters without sacrificing their advantages.

The accompanying diagrammatic drawing illustrates a cross-sectional elevation of one specific form of furnace embodying the features of the invention.

Referring to the drawing, the main furnace structure comprises side walls 1 and 2, a floor 3 and end walls which are not indicated in the particular view of the furnace here illustrated. These walls are preferably constructed of suitable refractory material such as ordinary firebrick, fireclay shapes or the like and are preferably insulated on their outer surface and weather-proofed either by painting or coating the exterior surface with suitable waterproofing material or by housing all or a portion of the furnace with sheet steel or other material such as rigid sheets composed of asbestos fibre and portland cement. Insulating material is indicated in the drawing at 4.

The upper portions of side walls 1 and 2 are arched toward the center of the furnace and continue upward for a relatively short distance to define, together with the end walls, a heating zone 7 of reduced cross-sectional area relative to the lower portion of the furnace which comprises combustion zones 5 and 6.

A hood 8 and a stack 9 containing a suitable damper 10 are superimposed above heating zone 7.

Suitable burner blocks 11 containing firing ports 12 are provided in the floor of the furnace through which fuel, such as gas and air, is supplied to each of the combustion zones 5 and 6 and in the particular case here illustrated other burner blocks 13 containing firing ports 14 are also provided to permit firing with oil in addition to or instead of gas. Preferably parallel rows of such burner blocks 11 and 13 are provided for each combustion zone although only one of each type of burner block for each combustion zone is shown in the sectional view of the furnace here illustrated. Gas may be admitted from each of the headers 15 to each of the firing ports 12 through suitable tips or nozzles 16 adjacent each of the burner blocks 11 and air for supporting combustion of the gas may also be admitted to firing ports 12. A suitable oil burner 17 is provided beneath each of the burner blocks 13 through which a mixture of atomized oil and air is admitted to each of the combustion zones through firing ports 14. Headers 18 and 19 are provided for oil and compressed air with communicating lines 20 and 21 leading to each burner and provided, respectively, with regulating valves 22 and 23. Additional air may be admitted through each of the firing ports 14 to combustion zones 5 and 6 in regulated quantities controlled by means of suitable dampers or other regulating means such as indicated, for example, at 24. Suitable regulating means may, of course, also be provided for the air supplied to ports 12, although not illustrated in the drawing.

Preferably, each of the burner blocks on opposite sides of the furnace and/or the firing ports contained therein are inclined at a slight angle toward the adjacent side walls 1 and 2 respectively so that the flames resulting from combustion of the fuel supplied to each of the combustion zones and the resulting hot combustion gases impinge upon and flow in a general upward direction over the refractory side walls, heating the latter to a highly radiant condition. The combustion gases leaving combustion zones 5 and 6 continue to travel in a general upward direction through heating zone 7 and hood 8 to stack 9 so that there is a substantially straight or stream-line flow of combustion gases in a general upward direction throughout the entire furnace.

A fluid conduit comprising the "equiflux" bank of tubes 25 which, in the particular case here illustrated, comprises two parallel, vertical rows of horizontally disposed tubes 26, is located centrally between combustion zones 5

and 6, each tube extending between the end walls of the furnace within the heated zone and adjacent tubes in the same or opposite rows being connected in series at their ends and outside of the combustion zone by means of suitable headers or return bends, not illustrated. Preferably the tubes in opposite rows of bank 25 are arranged in staggered formation with a space between adjacent tubes in the same row equal to or greater than the outside diameter of the tubes so that the opposite sides of each of the tubes 26 is subjected to heating by direct radiation from the materials undergoing combustion in combustion zones 5 and 6 from the hot refractory side walls 1 and 2, thereby subjecting each tube to high furnace temperatures and to high rates of heating.

With parallel flow of oil or other fluid to be heated through adjacent tubes in each row of bank 25 in either a generally upward or generally downward direction either substantially uniform or different heating conditions may be maintained in combustion zones 5 and 6 to control the heating curve of the fluid undergoing treatment by independently controlling the quantity of combustible materials supplied to each combustion zone. As an additional means of obtaining the desired type of heating curve the relative proportions of fuel and excess air supplied to each combustion zone may be varied to control the furnace temperature and heating conditions at different points along the length of tube bank 25. For example, by employing a short luminous flame and a relatively small amount of excess air, a large amount of heat may be concentrated adjacent the lower portion of tube bank 25 or, by employing larger amounts of excess air and non-luminous or less luminous flames, a relatively greater amount of heat may be concentrated about the upper portion of tube bank 25. Preferably, in case series flow is employed between adjacent tubes in opposite rows of bank 25, substantially uniform heating conditions are maintained in combustion zones 5 and 6 so that each individual tube of bank 25 is subjected to substantially equal heating conditions on opposite sides thereof and in such cases the proportion of fuel and excess air supplied to the two combustion zones is substantially the same.

A separate tube bank 27 comprising, in the particular case here illustrated, a plurality of superimposed horizontal rows of horizontally disposed tubes 28 is provided within heating zone 7. These tubes also preferably extend between the end walls of this zon and may be connected outside the heating zone either in parallel or in series or partially in both manners by means of suitable headers or return bends, not illustrated. The hot combustion gases from combustion zones 5 and 6 contact the exterior surface of each of the tubes of bank 27, imparting heat thereto and to the oil or other fluid passing through the tubes thereby reducing the temperature of the combustion gases passing to stack 9.

The present invention is not particularly concerned with the specific flow of the fluid undergoing treatment through tube banks 25 and 27 but one of the advantages of the furnace described is the wide degree of flexibility of operation obtainable by employing different specific flows through the various rows of tubes and through the separate tube banks as well as by variations of the firing conditions in each of the combustion zones. The apparatus is adaptable to the treatment of one or more streams of the same or different fluids each of which may be subjected to the same or to independently controlled heating conditions.

Although the furnace here illustrated comprises what is ordinarily termed a single cell "equiflux" furnace, the invention is equally well adapted to the use of a plurality of equiflux cells (each cell comprising an "equiflux" tube bank and two independently fired combustion zones) and a separate heating zone, similar to that indicated at 7 in the drawing, may be employed for each cell with the combustion gases from each of these zones supplied to a common flue or stack or, when desired, two or more cells may supply combustion gases to a single heating zone preferably located above the "equiflux" cells and centrally in relation thereto.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A process for heating fluids and particularly for heating hydrocarbon oils to the high temperatures required for their pyrolytic conversion, which comprises passing oil through horizontal tubes of a vertical tube bank disposed between two combustion and heating zones, heating opposite sides of each of said tubes by direct radiation from materials undergoing combustion within said combustion zones, supplying controlled amounts of combustible fuel and air to the lower portion of each of

said combustion zones, and causing th resulting flames and combustion gases to pass in a generally upward direction throughout the entire length and out of each combustion zone, the combustion gases passing through each of the two combustion zones in substantially streamline flow and being removed through an outlet located centrally above said combustion zones and the tube bank.

2. Process as claimed in claim 1, in which the two combustion zones are independently fired by supplying controlled amounts of combustible fuel and air through the floor of the combustion zones in a generally upward direction independently into each of said combustion zones.

3. Process as claimed in claim 1 or 2, in which the combustion flames and gases are directed in a substantially upward direction and at a slight angle toward refractory side walls of the two combustion zones located on opposite sides of the vertical tube bank, which is disposed centrally between the said walls, said side walls are heated to a highly radiant condition and heat is imparted to opposite sides of each tube of said vertical tube bank by direct radiation from the combustion flames and gases and from the hot refractory side walls.

4. Process as claimed in any of the preceding claims, wherein combustion gases are removed in a generally upward direction from each of the combustion zones through a separate heating zone located above and centrally in relation to the combustion zones and heat is imparted in said heating zone by convection from the combustion gases to a fluid, preferably oil, to be heated while passing through tubes of a separate tube bank disposed in said heating zone.

5. A furnace for heating fluids in the manner set forth in any of the preceding claims and particularly for heating oils to conversion temperatures, comprising in combination refractory side walls, end walls and a floor, a vertical bank of tubes for the fluids to be heated disposed centrally between the side walls, a combustion zone between each side wall and the adjacent side of the vertical tube bank, means in the lower portion of the furnace for introducing combustible fuel and air in a generally upward direction into the lower portion of each combustion zone and means for removing combustion gases from the combustion zones in an upward direction at a point above said vertical tube bank, said refractory side walls being located at a distance from the tubes of said vertical tub bank which permits the heating of said tubes substantially by radiation from the combustion flames and from the refractory side walls, the construction being such that an upper portion of each side wall extends above the vertical tube bank and arches towards the centre of the furnace and vertical continuations of the end walls and of said side walls extend above the arched portions of the latter to form a channel for the combustion gases to be discharged from the furnace to a stack.

6. Furnace as claimed in claim 5, wherein the extensions of the end walls and of said side walls above the arched portions of the latter define a separate heating zone, a separate bank of tubes to be heated by convection by the combustion gases is arranged within said separate heating zone, a combustion gas passageway is provided above said separate heating zone to provide for the passage of the combustion gases to the stack and ports for introducing combustible fuel and air are provided in the floor of the furnace.

7. Furnace as claimed in claim 5 or 6, wherein rows of firing ports are provided in the floor of each combustion zone for supply of combustible materials and air in a generally upward direction independently into each of said combustion zones, the firing ports and/or the burners directed into said firing ports being preferably arranged at a slight angle relative to the vertical axis of the furnace to direct the combustion flames and gases upwardly and slightly towards the refractory side walls.

8. Furnace as claimed in any of claims 5, 6 or 7, wherein the vertical tube bank is composed of two vertical rows of horizontal tubes, the opposite sides of each tube being freely exposed towards the refractory side walls, the tubes in the opposite rows being arranged in staggered formation and the space between adjacent tubes in the same row being preferably equal to or greater than the outside diameter of the tubes.

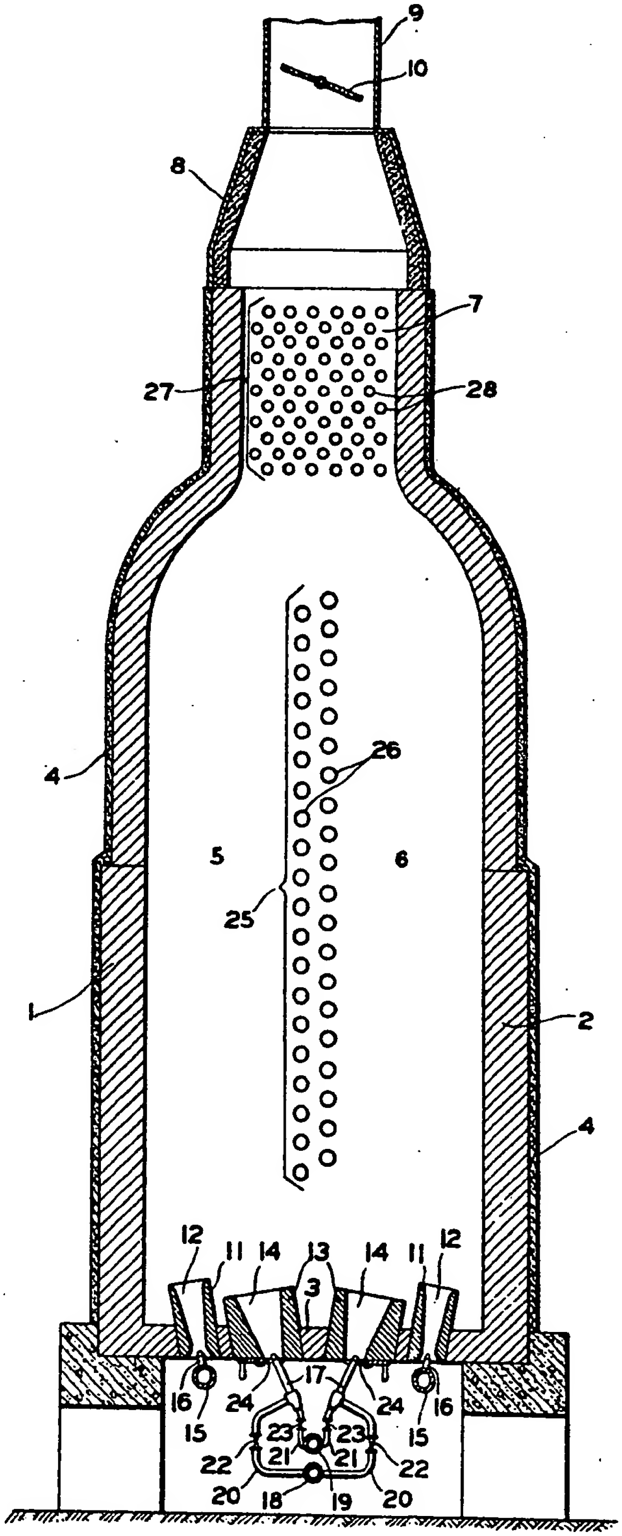
9. The process for heating fluids, substantially as described.

10. A furnace for heating fluids constructed, arranged and adapted to operate substantially as described with reference to the accompanying drawing.

Dated this 31st day of March, 1937.
ALBERT L. MOND,
19, Southampton Buildings,
Chancery Lane, London, W.C.2,
Agent for the Applicants.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1938.

[This Drawing is a reproduction of the Original on a reduced scale.]



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